STANDARD OIL
ENGINEERED MATERIALS

Memorandum

To: S. C. DeSutter

Date: 10/6/87

From: L. P. Bucknell

Copy to: ST Staff

Subject: October 5, 1987 Staff Meeting Notes -- Revised Edition

Next monthly meeting will be November 2, 1987, at 9:00 a.m. in the conference room.

Marketing Highlights

Sold eight monitors in September.

Three turf sales are tentative for the month of October. The major problem in selling the turf monitor is the fact that superintendents of golf courses are not the decision makers. Once the superintendent is sold on the idea of the ST27™ Turf Monitor, it must be presented to the board of directors of the golf course for approval. Boards meet either once a month or every other month and orders are pending board approvals.

A sales blitz was held in Arizona during the last week of August to promote the Scheduler® Plant Stress Monitor for CCT Corporation. Four Schedulers were sold during this blitz.

Customer Service/Product Performance and Distributing Representative questionnaires were mailed out to all Scheduler owners and sales personnel on September 16. Responses are starting to arrive. We have received eleven Customer Service/Product Performance and six Distributing Representative completed questionnaires to date.

Tino Lopez has mailed out a brochure and cover letter describing the ST27™ Turf Monitor to 100 leading golf courses and country clubs in California and Arizona to promote the sale of the turf monitor. Six responses have been received to date.

CCT Corporation has sold the first Scheduler to Mexico. A direct sale for three Schedulers has been shipped to Washington DC for further shipment to Mexico. The goal is to sell 20 units in Mexico by the end of 1987. Al Trujillo, sales representative, was added to the sales force in September. He will concentrate his efforts in South America, Mexico and New Mexico.

Marketing Objectives

Sell approximately 60 units by the end of the year, approximately 20 during the month of October.

Set monthly objectives for Tino Lopez, Western Regional Manager.

By October 12 define the 1988 marketing plan including the number of dealers anticipated, the advertising plan and ad development.

Develop a one-page promotion on the Hot Spotter.

Attend and display the Scheduler, ST27 and Hot Spotter at the Irrigation Association's show (Orlando, Florida) at the end of October. In conjunction with the show, put out a direct mail program to the Florida golf courses inviting them to the show to see the turf monitor, and a direct mail program to our sales leads in the surrounding states inviting them to the show. Include in the invitation a card for free admission to the show.

Obtain space reservations for the National Golf Course Show in February, 1988.

Attend the Vineyard Water Management seminar in Fresno in October.

Meet with John Lake to discuss in-store display campaign.

Tino Lopez will conduct primary interviews for a Western Region Sales Representative for California at three different schools: Cal-Poly University, Fresno State University and the University of California at Davis. Korbin Riley will conduct the secondary interview.

Provide product support for Cal-Coast Irrigation.

Attend the Front Line Management course at the BP America training center, Cleveland.

Production Highlights

Nine returned units during the month of September. Five consignment returns, two for new configuration and two coiled cord failures. The failure is due to stress caused by bending the cord when the monitor is packed into the carrying bag. Solutions are being sought. Possible symptoms of failure are bad bargraph readings, bad sensor readings, bad stress index reading due to timing. Damage to cord is visible. Expecting to see more returns due to this failure.

Fourteen shipments during the month of September. Eight units sold, two new consignment units, two failed cord units replaced and two units shipped with new configurations.

Currently 639 monitors in inventory. Current value of raw materials $63,000.

Apsco's IRT materials have been brought to Solon as well as all parts and materials from MOOG. Negotiations with MOOG for $60,000

in credit for overcharges is in progress with Gary Smith of Niagara Falls purchasing department.

Production Objectives

Attend the Front Line Management course at the BP America training center, Cleveland.

Finish the design detail drawings for prototype of the Hot Spotter and start to build prototypes. Three prototypes need to be built by October 23 for presentation at the Irrigation Association show.

Proposal is being prepared for the design of software for weather station use.

Illustrations for the Hot Spotter need to be drawn up.

Due to the expiration of contracts, the lab is minus three employees. Therefore, everyone will need to pitch in with the shipping and receiving responsibilities.

Monitors and batteries are stored in the cage in the basement of this building. A demonstration section has been established for used Schedulers. Other inventory is stored in bins in the lab area. Currently, the plan for tracking inventory is to tally items used and check inventory status every six months. An ongoing objective is to search for a better way to keep track of inventory. A barcoding system is currently being reviewed.

Technical Highlights

Presentations were made to the US Committee on Irrigation and Drainage in Denver and the Jojoba Association in Phoenix.

Asparagus and pecan baselines have been tested with the results being favorable.

An orange and lemon tree experiment has been started with a management company in Yuma.

Computer evaluations on watermelon, potato, cucumber, and green bean crops have been received from researchers and are being processed.

Developed an error analysis algorithm which is used in the development of the Hot Spotter.

Technical Objectives

Publish a list of salable baselines.

Chilis baseline is in the mail from researcher. Will be evaluated as soon as it arrives.

Will make a presentation to the Viticulture and Enology Research Center in Fresno.

Barry Bates is looking to prepare a software program for the R&D monitor. We will put him in touch with Niche Software and Barry will debug the program they have prepared.

Continuation of the sales efforts for the centers of excellence program with phone calls and a direct mail letter to the professors at the upcoming Agronomy Society meeting in November.

Finish watermelon, jojoba, potato, cantaloupe, cucumber, green bean baseline data.

Obtain orange and almond data for Irrigation Association show.

Develop graphics, chart and breaks-in-line for the Hot Spotter.

The new generation of irrigation and crop management technology.

The Scheduler Plant Stress Monitor represents a marked improvement over conventional instruments used in irrigation scheduling. That's because conventional instruments have been generally limited to monitoring soil moisture. The technology simply did not exist to account for other factors that affect plant health, such as diseases, insect damage, soil compaction or soil type variations. And those factors do affect irrigation requirements.

Scheduler bridges this technology gap. Because it monitors the actual condition of the plant, not the soil moisture.

By measuring plant stress and reporting it as a crop stress index, Scheduler can accurately show the crop's physiological state. This information can then be used to make irrigation scheduling and other crop management decisions before plants display any outward signs of stress. And that allows you to:

- Increase profits by applying the exact amount of water needed at critical stages of growth for top yields with maximum efficiency.
- Decrease costs by maintaining optimum plant growth with the fewest resources possible.
- Make irrigation and crop management decisions based on the crop's needs.

How Scheduler gives you the information you need, when you need it.

Scheduler is used in the field to read and record plant leaf temperature, ambient temperature, relative humidity and solar radiation load (degree of plant exposure to sunlight). This data is then processed by the system to establish the crop's stress status.

Extensive government, university and private research has been used to develop crop models that identify the plant to environment relationship. Scheduler uses these crop models, along with the field information it gathers, to detect crop stress, often several days before any symptoms of trouble become physically evident.

This means you can avoid crop damage and reduced yields caused by waiting too long to irrigate. It also means you can avoid expensive overirrigating by knowing when moisture is not required.

And, when used in conjunction with other scheduling methods and equipment, Scheduler can be a valuable troubleshooting tool.

This versatility makes Scheduler an indispensable tool for irrigation and crop management.

For more information, consult your local representative or contact:

STANDARD OIL
ENGINEERED MATERIALS

Standard Oil
Engineered Materials Company
6180 Cochran Road
P.O. Box 391316
Solon, Ohio 44139
216 349-6881

The information, recommendations, and opinions set forth herein are offered solely for your consideration, inquiry and verification and are not, in part or total, to be construed as constituting a warranty or representation for which we assume legal responsibility. Nothing contained herein is to be interpreted as authorization to practice a patented invention without a license.

Form A-15,050 Rev. 3/87
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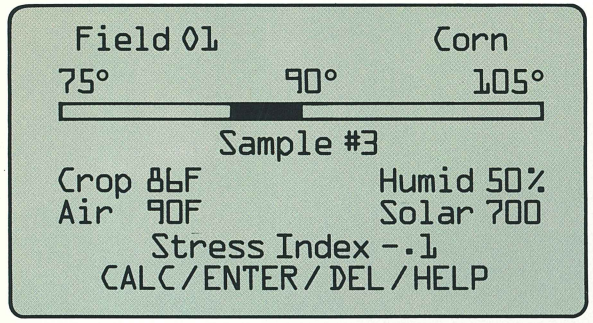
Printed in U.S.A.

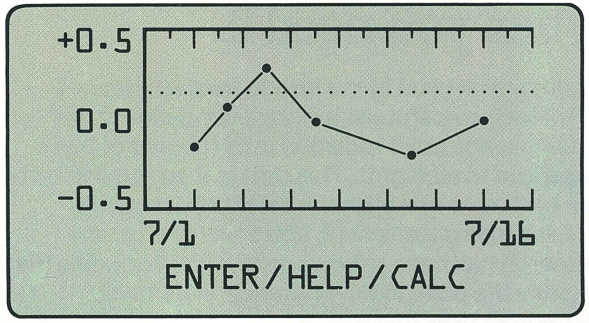
WHEN?

Measure crop stress—accurately and objectively—for optimum irrigation scheduling and crop management.

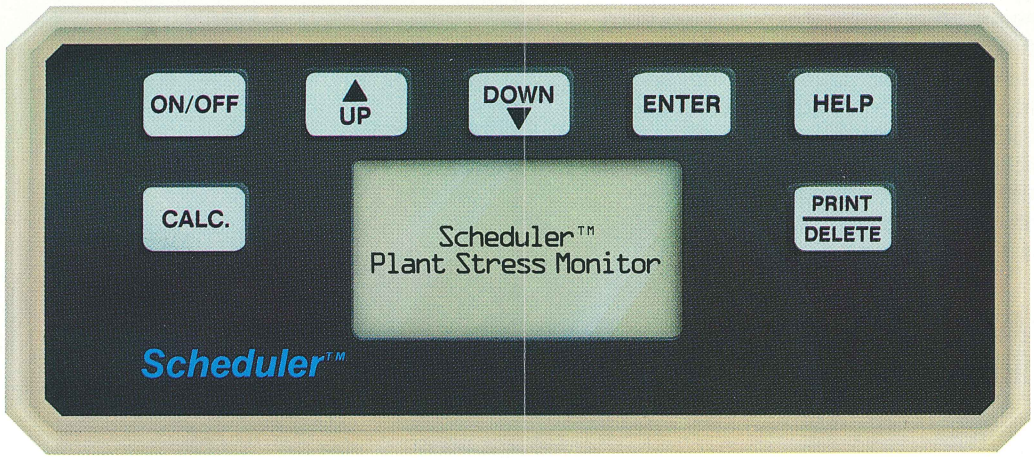
SCHEDULER™ Plant Stress Monitor

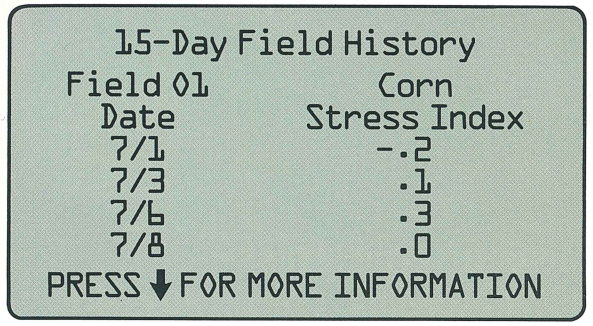


Sampling—Sensor readings are displayed along with the current sample's stress index. The horizontal bar graph is a computerized "aiming aid" for accurate sample recording.

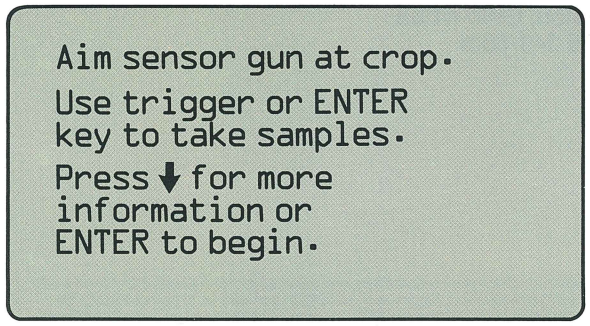


Charting—A plant stress record is charted over a 15-day period. Monitor stress trends, analyze irrigation effectiveness and project irrigation requirements. You create the chart automatically every time you visit the field.





Memory—Information can be stored and recalled on a field-by-field basis. For a permanent record, information can be transmitted to a printer or microcomputer for storage or printout.



Help—If you have a question, simply press the "Help" key and Scheduler's user-friendly software will take you step by step through the program.

Engineered for today's agricultural needs.

Lightweight, portable, battery-powered Scheduler™ Plant Stress Monitor is the result of years of research by the Standard Oil Company in cooperation with government and university personnel. *But our research didn't end in a laboratory.* Scheduler was also extensively field tested under actual conditions on farms like yours to assure long-term durability and accuracy. The result is a system that is reliable, powerful and yet simple to use.

Scheduler Plant Stress Monitor features include:

- Integrated Sensor Package—The easy-to-handle sensor gun accurately measures the plant's condition and its immediate environment. An infrared thermometer records plant canopy temperatures. Solar radiation is measured to gauge the plant's exposure to sunlight. Relative humidity and ambient temperature sensors also provide vital information on the crop's environment.
- Microprocessor—Complex calculations are made in seconds at the push of a button. The information is then presented in a simple, management-oriented format suggested by growers during field tests.
- LCD Display—A special display screen was chosen because it's easy to read in bright sunlight. You don't need any extra computer support. The display is a complete communications link between you and the system.
- Battery Backed-up Internal Memory—Two full weeks of information can be stored and updated automatically from multiple field locations.
- Optional Extension Pole—This convenient accessory makes it easy to extend the sensor gun above tall crop canopies.
- Computerized Aiming Aids—The computer locks you on target for accurate readings every time.
- RS232 Serial Port—Download daily information for permanent records.
- Rugged Construction—We know that for Scheduler to be a valuable tool, it has to stand up to abuse in the field. But it also has to be lightweight and compact. Scheduler has been engineered to meet your demands.

Effective 8/24/88

SCHEDULER DISTRIBUTORS

	PHONE	FN	COMPANY	ADDRESS	ADDRESS2	CITY	ST	ZIP
1	602/853-0077	Shelby A. Carl	CCT Corporation	P.O. Box 46		Avondale	AZ	85323
2	602/835-0103	Tino Lopez	Std. Oil Engineered Mtls.	1506 East Fairfield		Mesa	AZ	85203
3	602/963-4623	Gordon Miller	Western Farm Service	P. O. Box 528	Cloud & Rittenhouse R	Queen Creek	AZ	85242
4	602/344-4500	Chuck Warner	Yuma Sprinkler & Pipe Supply	P. O. Box 5389	2291 East Palo Verde	Yuma	AZ	85364
5	209/333-1599	Mike Manna	Acampo Ag Service	775 E. Acampo		Acampo	CA	95220
6	619/344-3630	Curtis Pate	Dune Company	1644 Jones Street		Brawley	CA	92227
7	209/221-1476	Ron Brase	Applied Technology Prod.	1557 W. Shaw		Fresno	CA	93711
8	209/673-4892	Steve Carl	CCT Corporation	18798 Farallon		Madera	CA	93637
9	805/922-6943	William Bogue	Pacific Ag Water Inc.	P. O. Box 1874	1520 E. Donovan Rd	Santa Maria	CA	93456
10	805/922-8406	Duane Campbell	Cal-Coast Irrigation Inc.	1480 West Stowell Road		Santa Maria	CA	93454
11	209/951-6059	Bill Maupin	Std. Oil Engineered Mtls.	7523 Oakcreek Drive		Stockton	CA	95207
12	209/934-7774	Jim Clare	Golden State Irrigation	4011 South Highway 99		Stockton	CA	95205
13	208/425-3585	Bart Christensen	Kenneth O. Christensen Farms	Rte. 1, Box 40		Grace	ID	83241
14	208/438-8103	Dale Adams	Butte Irrigation	P. O. Box 757	1/4 Mile S. Hwy 27	Paul	ID	83347
15	208/356-9036	Dale Jeppesen		1347 North 1000 East		Rexburg	ID	83440
16	314/757-6219	Damon Bush	Bush Sales & Service	2000 Connton Rte I		Bragg City	MO	63827
17	601/332-3555	Johnny McRight	McRight Agri-Management	PO Box 4812	VFW Road	Greenville	MS	38704-4812
18	402/947-9881	Randy Miller	Miller Agri-Sales	1121 Fifth Street		Friend	NE	68359
19	402/748-3388	Bob Steel	Petersen & Son, Inc.	P. O. Box 207		Osmond	NE	68765
20	806/935-7765	Jerry Wakefield	Circle L Irrigation	Rtter Route, PO Box 97D		Dumas	TX	79029
21	806/272-4483	Don McKlroy	Irrig. Pump & Power Inc.	Box 313		Muleshoe	TX	79347
22	509/488-5623	Dale Bowers	Sargent Pump & Irrigation	1155 South Broadway		Othello	WA	99344
23	715/344-4747	Paul Roberts	Roberts Irrigation	408 Post Road		Stevens Point	WI	54481

SCHEDULER SALES REPS

	PHONE	FN	COMPANY	ADDRESS	ADDRESS2	CITY	ST	ZIP
1	707/257-6633	Steven Soper	The Water Works	647 Trancas Street	P. O. Box 3989	Napa	CA	94558
2	408/484-1808	John Sandys	IrriDrain	30 Hitchcock Road	P.O. Box 2022	Salinas	CA	93902
3	505/525-1545	Alfred L. Trujillo	T & N International Inc.	P. O. Box 6374	1924 Highland	Las Cruces	NM	88006
4	806/864-3314	Darrell Holley	Holley Fertilizer	HCOI, Box 41		Plainview	TX	79072
5	619/922-0321 x2859	Richard Wellman	Little Feat Farms	349 N. Acacia		Blythe	CA	92225

ST27 DISTRIBUTORS

	PHONE	FN	COMPANY	ADDRESS	ADDRESS2	CITY	ST	ZIP
1	602/277-1300	Bernie Atutis	Karsten Mfg Corporation	2201 West Desert Cove	P. O. Box 9990	Phoenix	AZ	85029
2		Lon Records	Target Specialty Products Inc.	17710 Studebaker Road	Box 1117	Cerritos	CA	90701
3	213/459-4412	John Keeling	Turf Technology Co.	P. O. Box 160		Pacific Palisades	CA	90272
4	312/668-5537	Walter Fuchs	Turf Products Limited	2N255 County Farm Road		West Chicago	IL	60185
5	313/437-1427	Eugene Johanningsmeier	Turf Grass Inc.	P. O. Box T365	Woodland Drive	South Lyon	MI	48178
6	516/567/5707	Lance Authelet	AWI Golf Course Consultants	1121-32 Lincoln Ave		Holbrook	NY	11741
7	216/456-4114	Gary Stewart	Turf & Nursery Supply, Inc.	P. O. Box 7007	3709 Columbus Rd NE	Canton	OH	44705-0007

SCHEDULER INTERNATIONAL DISTRIBUTORS

	PHONE	FN	COMPANY	ADDRESS	ADDRESS2	CITY	COUNTRY	ZIP
1	61/55-772475(FAX)	Tom Napier		P. O. Box 501	Victoria Valley	Victoria	Australia	3294
2	209/266-8713	Larry Miller	Trans-Rim Trading Ltd.	1713 Tulare Street #135		Fresno	CA	93721
3	403/223-3591	Gordon Green	New Way Irrigation	Box 1889		Taber, Alberta	Canada	T0K2G0
4	031-71261 RAJ IN	Satish Aneja	Klron Instrument Co.	B-2, Satkar Bldg; 79-80,	Nehru Place	New Delhi-110019	India	
5	39/51/453570(FAX)	Anna Tosi	Gramigna S.p.A.	Via Caselle 47		S. Lazzaro	Italy	40068
6		A. O. Ayeni	Frigoscandia Farms Co. Ltd.	Block One, Coop Estate	P. O. Box 586	Ikare-Akoko	Nigeria	
7	343/317-9678(FAX)	Xavier Sarre	Raimat S.A.	Gran Via 644		Barcelona	Spain	08007
8	713/871-0169		Lindsay Internatl Sls Corp	3040 Post Oak Blvd. #1550		Houston	TX	77056
9	509/334-4412	Bob Hinrichs	American Ag International	Route 2, Box 606		Pullman	WA	99163

ST27 INTERNATIONAL DISTRIBUTORS

1	813/667-2260(FAX)	S. Suzuki	Honzawa Co. Ltd.	16-21 Koamicho NihonbashiChuo-Ku		Tokyo	Japan	103

CCT SUB-DISTRIBUTORS (SCHEDULERS)

	PHONE	FN	COMPANY	ADDRESS	ADDRESS2	CITY	ST	ZIP
1	209/864-3201	David Britz	Britz Fertilizer	P. O. Box 366		Five Point	CA	
2	209/268-9502	Pete Simonian		825 West California Avenue		Fresno	CA	93706
3	209/334-2732	Rich Newharth	Brea Ag Service Inc.	P. O. Box 1117		Lodi	CA	95241
4	209/883-4026	Howard Barnett	Hughson Chemical	P. O. Box 10	6800 E Whitmore Ave	Merced	CA	95326
5	209/383-1090	Walt Adams	Helena Chemical	400 Grogan Ave		Merced	CA	95340
6	209/582-0291	Randy Davis	Helena Chemical Co.	PO Box 1263 (Zip 93230)	12218 Eleventh Ave	Hanford	CA	93232
7	209/638-6311	Bob Higby	Gar Tootelian Inc.	8246 S. Crawford		Reedley	CA	93654
8	209/944-9951	Roy Stevenson	John Taylor Fertilizer Co.	P. O. Box 6098		Stockton	CA	95206
9	209/466-5911	Bob Newell/George Piccard	Brea Ag Service Inc.	P. O. Box 201059		Stockton	CA	95201
10	916/662-5442	John Miller	Agriform Farm Supply	P. O. Box 1818		Woodland	CA	95695
11	916/673-0921	Charlie Edgar/Bill Miller	John Taylor Fertilizer Co.	900 N. George Washington		Yuba City	CA	95991

This is our current list of available crop packages. Each Scheduler^{R} Plant Stress Monitor can be configured with up to seven of the crops below.

1989 CROP LIST

ALFALFA

ALMONDS

ASPARAGUS

CANTALOUPES

CARROTS

CORN

COTTON

BARLEY I & II

WHEAT I & II

SUGAR BEETS

WATERMELONS

PECANS

SOYBEANS

TOMATOES

POTATOES

JOJOBA

GRAPES

GRAIN SORGHUM

CUCUMBERS

APPLES

LOW

HIGH

THE CARBORUNDUM COMPANY

INSTRUMENT TECHNOLOGIES

PRICE LIST -- 1989

	Suggested Retail	Centers of Excellence Price
SCHEDULER[R] PLANT STRESS MONITOR	$4,500.00	$2,900.00
Includes Support Software		
CROPLINK[TM] CROP MONITORING SYSTEM		
Field Station System		
Air Temperature Sensor Capacitance Relative Humidity Sensor Licor Solar Radiation Sensor Wind Speed Sensor (Annometer) Weatheredge[TM] Infrared Thermometer Solar Panel (Automatic Recharger) Infrared Telemetry System	$4,600.00	$3,450.00
One Base Station System	1,900.00	1,250.00
CropLink Software Base Tranceiver RS232 Communications Cable Solar Panel (Recharger)		
Basic System Total Cost	$6,500.00	$4,700.00
Additional Components		
Weatheredge[TM] Infrared Thermometer (Shielded)	$ 450.00	$ 355.00
Radio Telemetry System (VHF-Frequency) (Add per Base or Field Station)	1,100.00	900.00
Tipping Bucket Rain Gage	290.00	230.00
Gypsum Block 6' Wire	15.00	9.50
Repeater	580.00	500.00
Wind Direction	150.00	100.00
WEATHEREDGE[TM] INFRARED THERMOMETER		
*Shielded	$450.00	$390.00
*Unshielded	430.00	390.00
*Specify voltage or current output		

Prices Effective: March 1, 1989
Prices subject to change without notice.
Prices do not include shipping and taxes.

TechCon '89

TECHNOLOGY CONCEPTS for FOOD PRODUCTION & PROCESSING

Act Now!
*** Exhibit locations will be pre-assigned. Preference will be allowed in the order that exhibit commitments arrive at ASAE Headquarters.**

Exhibitors Agreement

New Orleans Marriott

Wednesday, December 13 — **9:30 a.m. to 2 p.m.**
4:15 p.m. to 6:30 p.m.
(Exhibitor presentations and refreshments)

Thursday, December 14 — **9 a.m. to 12 noon**

sponsored by the American Society of Agricultural Engineers
and
showcased in Agricultural Engineering magazine's Nov./Dec. issue

Company The Carborundum Company

Contact Bronson Gardner Title Product Technical Manager

Address P. O. Box 391377, 6180 Cochran Road

City/State/Zip Solon, OH 44139

Telephone (800) 356-0458

Check Type of Space Desired: Table _____ Booth ✓

Information for Identification Placard:

Company Name The Carborundum Company

City/State Solon, Ohio

Program Copy:

Give a brief description of proposed exhibit for program.
(i.e. machinery type, component type, literature)

Scheduler^{R} Plant Stress Monitor and the Croplink^{TM} Crop Monitoring System

Names of Representatives:
Provide names/nicknames of individuals who will be staffing your exhibit for name tags and programs.

Bronson Gardner = Bronson

Korbin Riley = Korbin

In accordance with the Contract Regulations governing the exhibits to be held at the New Orleans Marriott, December 13 - 14, 1989, the undersigned accepts and agrees to all terms and conditions of the following contract.

Lynn Buchwell
Authorized Signature

The Carborundum Company
Company

8/25/89
Date

Accepted by

Exhibit Coordinator

Exhibit Space Assignment (to be filled in by Exhibit Coordinator)

COMMON QUESTIONS GROWERS ASK ABOUT THE SCHEDULER

Is the Scheduler™ too scientific to learn to use and will it require training?

Ten to fifteen minutes of in-field training has always proven sufficient to make a new owner comfortable. The Scheduler's non-eraseable software program is written with the grower in mind. It will remind you if you've done something wrong and the software's "help" function will guide you to successful use. A twelve minute VHS training tape and operations manual are available.

I need to know when to water my crops before they are water stressed. Can the Scheduler tell me this?

Plants have the amazing ability to produce top yields when soil moisture is less than 100 percent of field capacity. For many crops Scheduler picks up reductions in plant transpiration days before the crop experiences visible stress. **Scheduler can tell you when your plants are well watered as well as stressed.**

I have always scheduled irrigation by measuring soil moisture. How does the Scheduler compare?

Managing soil moisture to maintain a "healthy plant" is what irrigation scheduling is all about. Measuring soil moisture can supply valuable information on water depth in the soil profile. Scheduler used in conjunction with your current system greatly improves the quality of your soil moisture information by providing direct "feed-back" from the plant. The Stress Index calculated by the Scheduler depends upon the plant's ability to extract moisture from the "root profile" which is usually an unknown when derived strictly from soil moisture information.

How is the system powered and do I need computer skills to operate it?

The system operates on six size C batteries with expected battery life of 20 hours of continuous operation. Of course, normal daily use is not a continuous effort and under these conditions one set of batteries will last about one month (rechargeable batteries available). No computer skills are required.

How many crops will one Scheduler analyze?

Each unit can hold crop specific models for up to seven crops. You can select the seven crops that best fit your operation.

Alfalfa	Almonds	Asparagus	Cantaloupes
Carrots	Corn	Cotton	Barley
Wheat	Sugar Beets	Watermelon	Pecans
Soybeans	Tomatos	Potatoes	Grain Sorghum
Jojoba	Turf Grass	Grapes	High
			Low

Since it detects plant stress, will it tell me if I have other cropping problems?

The Scheduler will react to any problem that reduces the plant's transpiration rate. This reduction is usually caused by the lack of available soil moisture, but if soil moisture can be eliminated as a possible cause, many disease or insect problems can be identified. They usually appear as "hot spots" and spread throughout the field where Scheduler can aid in early detection of these troubled areas.

What if I want to use the Scheduler on a crop not listed?

We have developed two "all-purpose" indexes. They are labeled as having high and low sensitivities. This means that the scale changes (on a relative basis) either a small amount (low sensitivity) or a large amount (high sensitivity) for each one degree Fahrenheit change in crop temperature. It is up to the user to select which index is best.

Can I use the Scheduler on young row crops where a lot of soil is exposed?

The measurement technique is different than for a crop where the soil is covered by the plant canopy. For young plants, it is necessary to sample individual plants, since the amount of exposed soil is large. The Scheduler samples at a rate of once every 1/4 second. In just seconds, a user can sample more area than would ever be practical with tensiometers or moisture blocks. Remember, small plants do not have the root capacity or leaf area of larger plants and they are often surrounded by hot soil. Their "normal" state is to be slightly stressed.

Is wind speed important?

Yes. Fluctuations in wind speed cause fluctuations in plant temperature. The need to measure wind speed is minimized since the Scheduler directly measures plant temperature and can collect a large number of samples to "average out" fluctuations.

Is the direction of the sun important?

It is important that the Scheduler sample only sunlit vegetation. Since many crops have a row structure (or shaded side) by keeping the sun at ones back, a user can insure that he is looking at the sunny side of the row instead of the shaded side.

Are clouds important?

Yes. The Scheduler will not calculate the plant stress index if the sunlight level is not high enough. This is because plant stress is maximized under sunny conditions and minimized under cloudy conditions. The Scheduler will tell you when the light level is too low.

How important is time of day?

Very important. To measure plant stress it is necessary to do it when the stress appears, which is generally "in the heat of the day." It is important to be consistent in the time of day when the Scheduler is used. We prefer a time frame of around noon to 4:00 p.m. In many locations, the Scheduler can be used effectively as early as 11:00 a.m.

POST SALE CALL REPORT

Date _____

Customer Name: _____

Farm Name: _____

On a scale of 1 - 10 how does he/she rate his product satisfaction? _____

Did you see the instrument? _____ Yes _____ No

If yes: What condition is it in?

Where is the instrument stored?

How much information is stored in the memory?

Does the customer have a computer? _____ Yes _____ No

If yes: Can he download Scheduler? _____ Yes _____ No

How often does he download? _____

Does he have software? _____ Ours _____ Niche

Mr. "Grower", are you comfortable with the Scheduler?

	Confused<---------->Expert				
Index interpretation	1	2	3	4	5
Aiming Technique	1	2	3	4	5
Data Analysis	1	2	3	4	5

Does he/she base irrigation or cultural practice decisions on Scheduler readings?

How frequently does he/she use the instrument? _____ Xs/Day _____ Xs/Week

Time of day _____ until _____

Does the information in the unit confirm user frequency? ___ Yes ___ No

Crops grown?

Crops instrument used on? (Include how well it works on each and why not used on other crops.)

Most experience on (crop)?

Least experience on (crop)?

Specific testimonial (good or bad) the user provided?

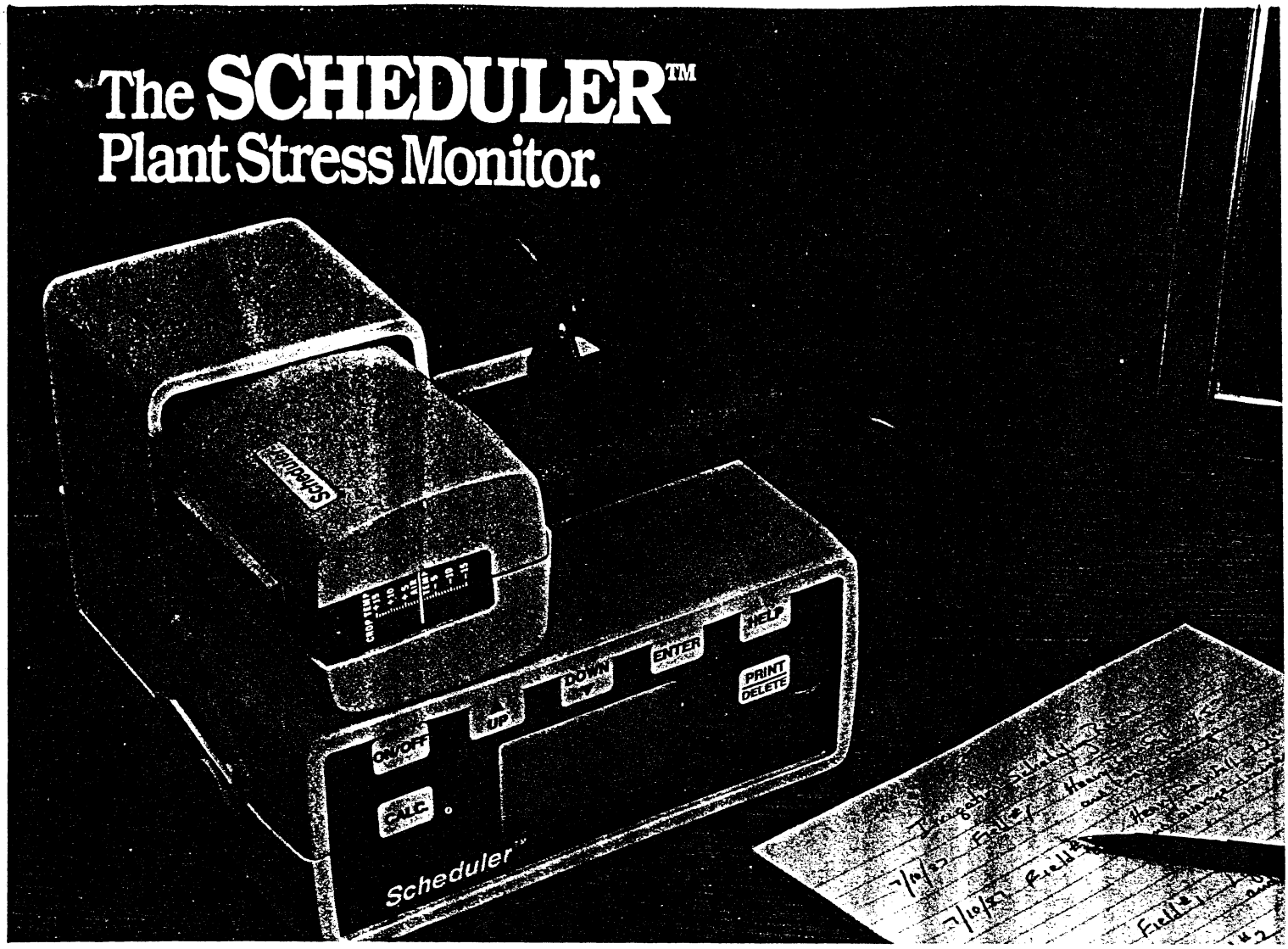
Specific areas in which you offered assistance.

Product improvements suggested by the user.

On a scale of 1 - 10, how do you rate this customer's satisfaction? _____

Give at least one reason for your rating.

The SCHEDULER™ Plant Stress Monitor.



It saves time. It saves water. And it just might save your crop.

Is your crop too wet? Too dry? Just right? Why not ask it?

The Scheduler™ plant stress monitor, the most advanced technology available today, is designed to answer those questions. Irrigation scheduling and cropping decisions can now be made based on "plant facts."

You know that the effective timing of irrigation is critical for the optimum use of water, time and energy resources, and that their wise and efficient use means money in your pocket. *A lot of money.*

How does the Scheduler work?

It's simple. The infrared thermometry-based system detects small changes in a crop's canopy temperature due to the change in the rate at which moisture is evaporating from the leaf's surface. It measures the plant in its field environment and predicts the onset of yield-robbing stress days before it could otherwise be visibly detected. The sensor system collects multiple field samples in seconds. Automatically calculating a crop stress index for each field.

What does this mean to you?

A whole new realm of control is placed in your grasp. Now the crop can provide direct information to you for improved management decisions. It can give you the security of knowing "you've done it right."

The lightweight, portable, battery-powered Scheduler is a "manager's tool"; it's simple to operate and requires no technical expertise. Use our Instant Action Card for complete information, fast.

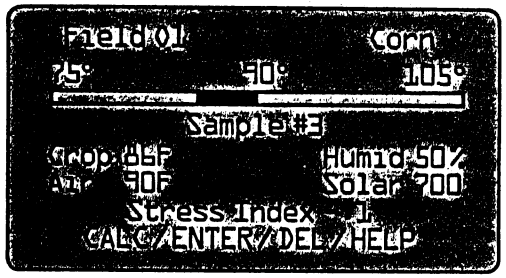
STANDARD OIL
ENGINEERED MATERIALS

Standard Oil
Engineered Materials Company
P.O. Box 156
Niagara Falls, New York 14302
216-581-5538/716-278-2000

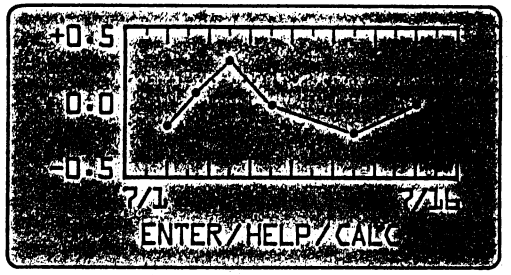
See the Scheduler in action at Booth 239-241 Int. Irrigation Expo. & Conf.

51

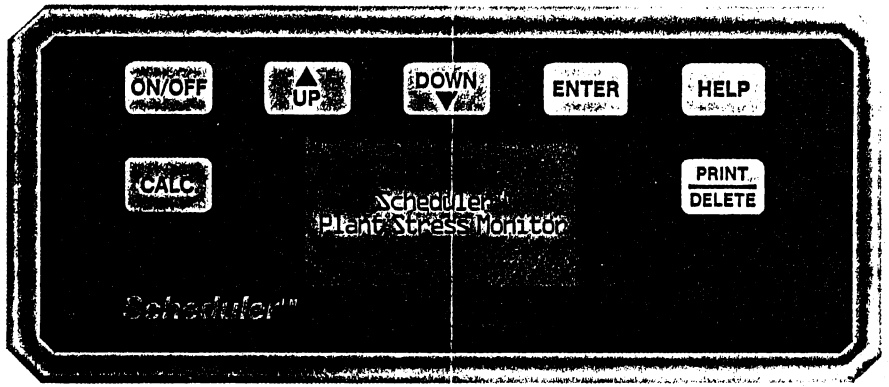
SCHEDULER™ Plant Stress Monitor

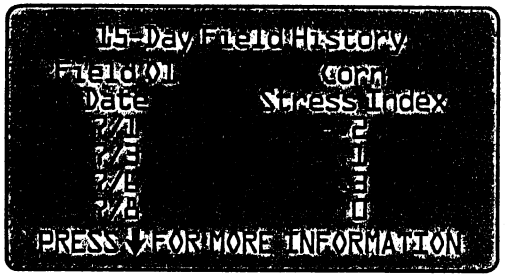


Sampling—Sensor readings are displayed along with the current sample's stress index. The horizontal bar graph is a computerized "aiming aid" for accurate sample recording.

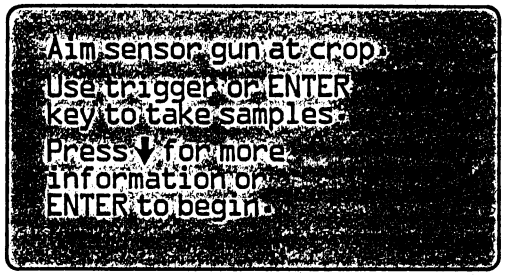


Charting—A plant stress record is charted over a 15-day period. Monitor stress trends, analyze irrigation effectiveness and project irrigation requirements. You create the chart automatically every time you visit the field.





Memory—Information can be stored and recalled on a field-by-field basis. For a permanent record, information can be transmitted to a printer or microcomputer for storage or printout.



Help—If you have a question, simply press the "Help" key and Scheduler's user-friendly software will take you step by step through the program.

Engineered for today's agricultural needs.

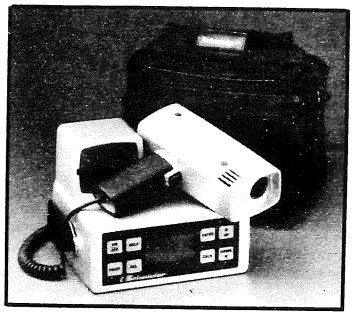
Lightweight, portable, battery-powered Scheduler™ Plant Stress Monitor is the result of years of research by the Standard Oil Company in cooperation with government and university personnel. *But our research didn't end in a laboratory.* Scheduler was also extensively field tested under actual conditions on farms like yours to assure long-term durability and accuracy. The result is a system that is reliable, powerful and yet simple to use.

Scheduler Plant Stress Monitor features include:

- Integrated Sensor Package—The easy-to-handle sensor gun accurately measures the plant's condition and its immediate environment. An infrared thermometer records plant canopy temperatures. Solar radiation is measured to gauge the plant's exposure to sunlight. Relative humidity and ambient temperature sensors also provide vital information on the crop's environment.
- Microprocessor—Complex calculations are made in seconds at the push of a button. The information is then presented in a simple, management-oriented format suggested by growers during field tests.
- LCD Display—A special display screen was chosen because it's easy to read in bright sunlight. You don't need any extra computer support. The display is a complete communications link between you and the system.
- Battery Backed-up Internal Memory—Two full weeks of information can be stored and updated automatically from multiple field locations.
- Optional Extension Pole—This convenient accessory makes it easy to extend the sensor gun above tall crop canopies.
- Computerized Aiming Aids—The computer locks you on target for accurate readings every time.
- RS232 Serial Port—Download daily information for permanent records.
- Rugged Construction—We know that for Scheduler to be a valuable tool, it has to stand up to abuse in the field. But it also has to be lightweight and compact. Scheduler has been engineered to meet your demands.

State-of-the-Art
CROP MONITORING

The Agricultural Engineering 50 1987



Scheduler®
Plant Stress Monitor

DETECTS STRESS
- Too little/Too much water
- Salt/Compaction/Insects/Disease/Chemicals

INCREASES EFFICIENCY
- Sample large areas FAST
- PC compatible
- Portable — sample anywhere

FIELD TESTED
- The first large-scale/nationwide test of the USDA crop water stress index (CWSI)
- The first commercial CWSI-based system
- Hundreds of university, government and private growers since 1985
- Validated on over 20 crops — Can be used on many more
- Scheduler customers are the largest group of CWSI users in the world

PRODUCT SUPPORT
- PC software for quick daily and seasonal reports
- Manuals/Tutorials
- Know-How bulletins for each crop
- 24-48 hour delivery anywhere in the United States
- 800 number for assistance

FEATURES

Infrared thermometer, air temperature, relative humidity, solar radiation, excellent data logging capacity.

Programmable for any CWSI equation.

Interfaces with polycorders and computers.

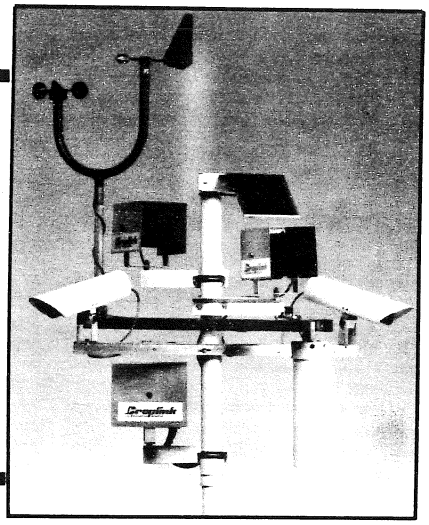
The Agricultural Engineering 50 1989

INFORMATION:
- Evapotranspiration
- Crop Water Stress Index
- Dew point
- Growing degree days
- Sensor alarms
- Live data display
- Graphs
- Min/Max, averages for each sensor
- Any analog, digital or event sensor

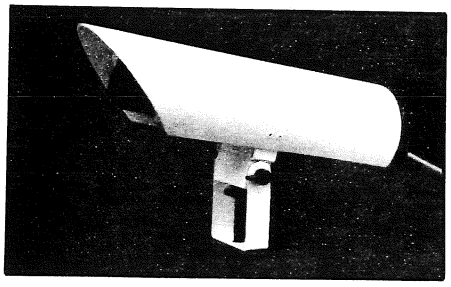
SOFTWARE:
- Menu driven
- Automatic file maintenance
- No manuals required
- No computer experience needed
- Research utilities:
  - selective file exporting
  - easy sensor calibration
  - summary statistics for each sensor
- Operate 1-10 stations simultaneously
- IBM compatible. Color or B&W
- Only 400 K RAM required

TELEMETRY:
- Infrared line of site for linking station in up to 1 mile intervals
- Radio when distance between stations is greater than 1 mile

STANDARD HARDWARE:
- Infrared thermometer
- Relative humidity
- Aspirated air temp
- Wind speed
- Wind direction
- Solar radiation
- Solar panel
- Field station
- Base station
- Quality sensors
- Low maintenance
- Add your own sensors



Croplink
Crop Monitoring Systems



WEATHEREDGE™ INFRARED THERMOMETER

...Greenhouse operators and weatherstation owners!...

Direct measurement of plant temperature is now available through the use of a high quality infrared thermometer manufactured by The Carborundum Company. This inexpensive infrared sensor has been ruggedly designed for indoor or outdoor application where the direct measurement of plant temperature can be used as an indicator of plant health. This linear sensor is offered in either current or voltage output and is easily added to any computer based monitoring/controller system.

FEATURES

• Low Cost • High Accuracy • Wide Temperature Range • • Durable Environmental Shield • • Wide Operating Voltage Range 5.2 - 30 D.C.V. • 3 Wire 0 -20 Ma. Current Loop Available •

OPERATIONAL SPECIFICATIONS

Target range	– 40°C to + 50°C	Repeatability	0.2°C
Spectral range	8-14 microns	Operating range	– 10°C to 70°C
Accuracy	+/– 1° Celcius	Response time	500 milliseconds
Emissivity	0.99		

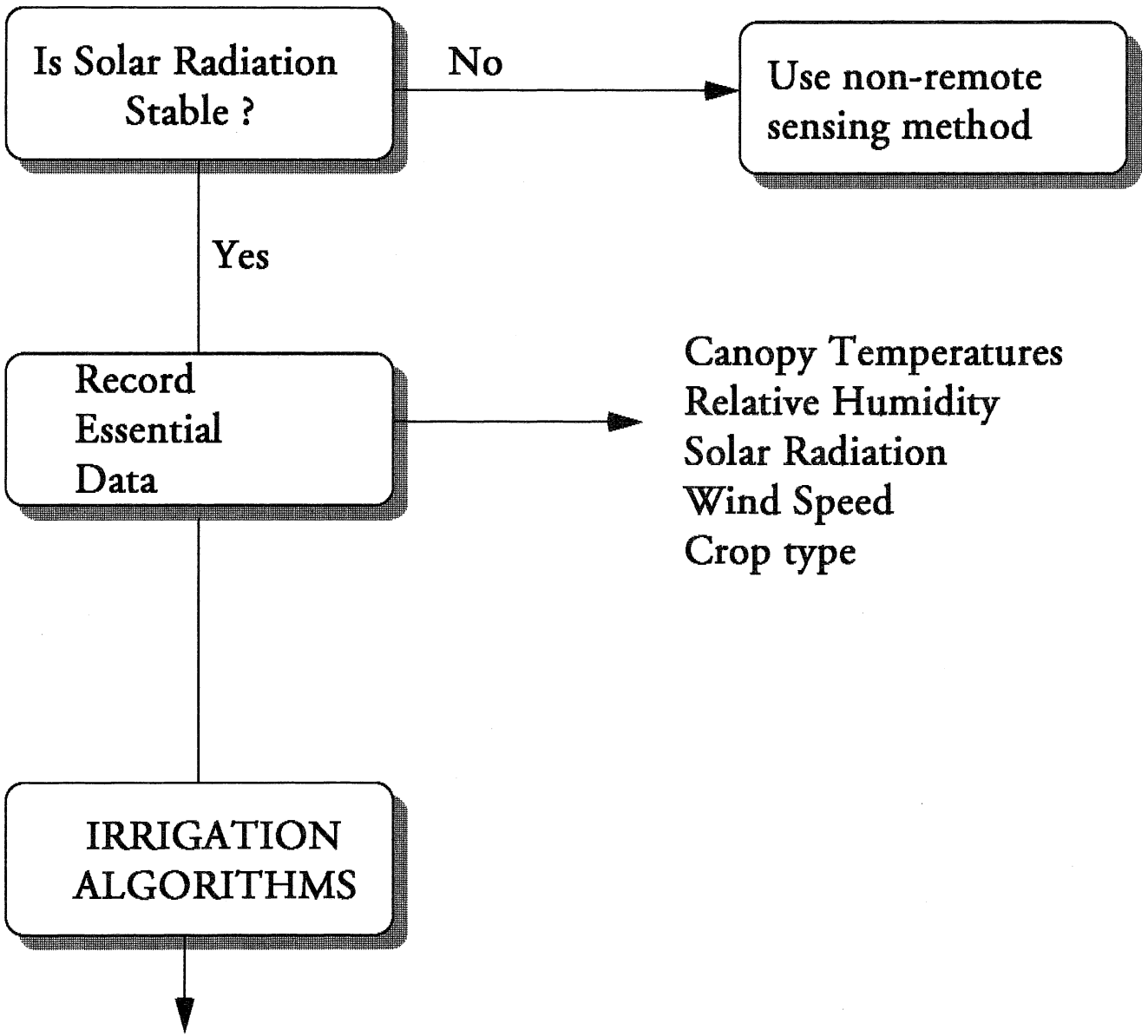
CARBORUNDUM

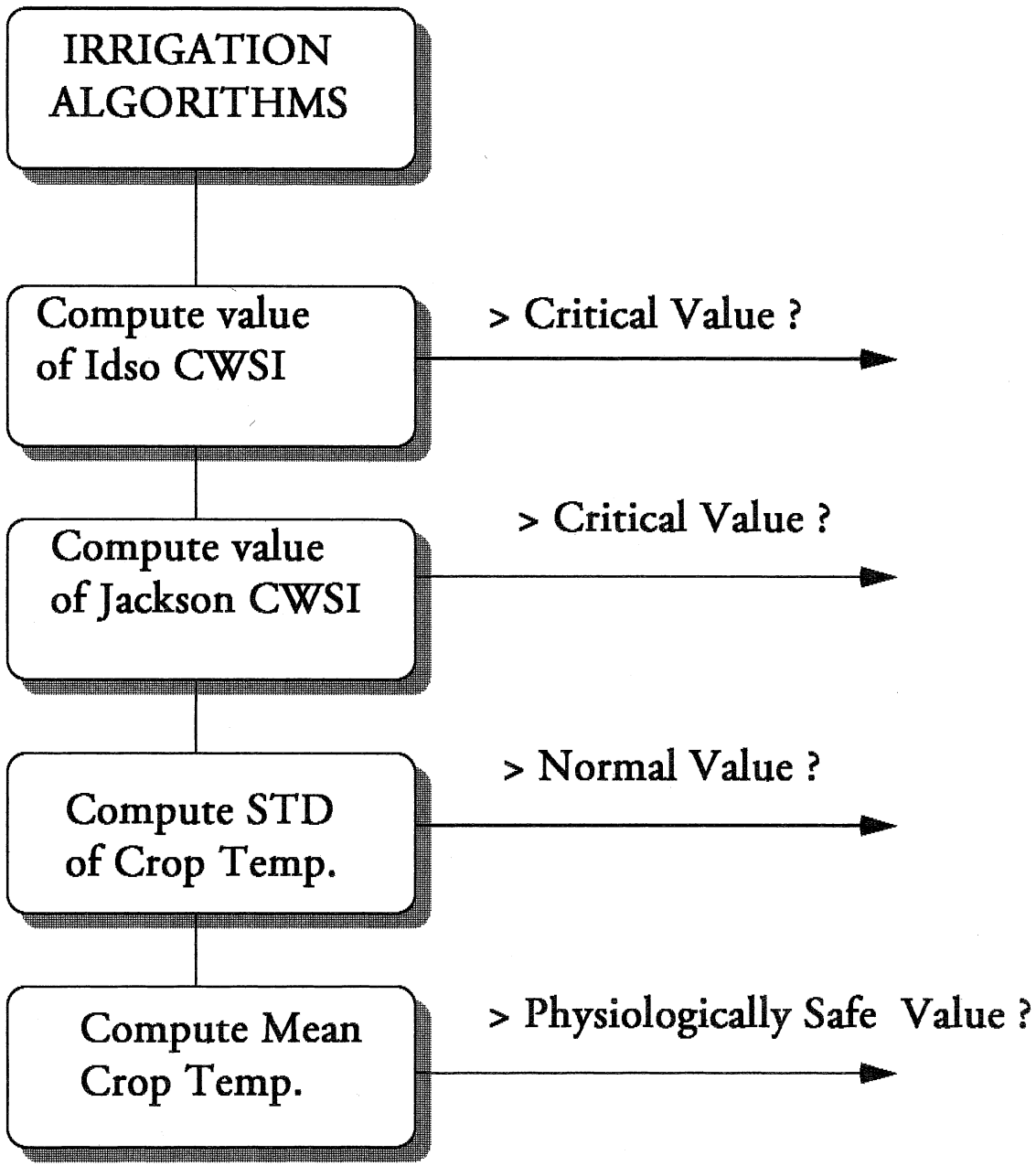
Instrument Technologies
P.O. Box 391377
Solon, OH 44139
(800) 356-0458

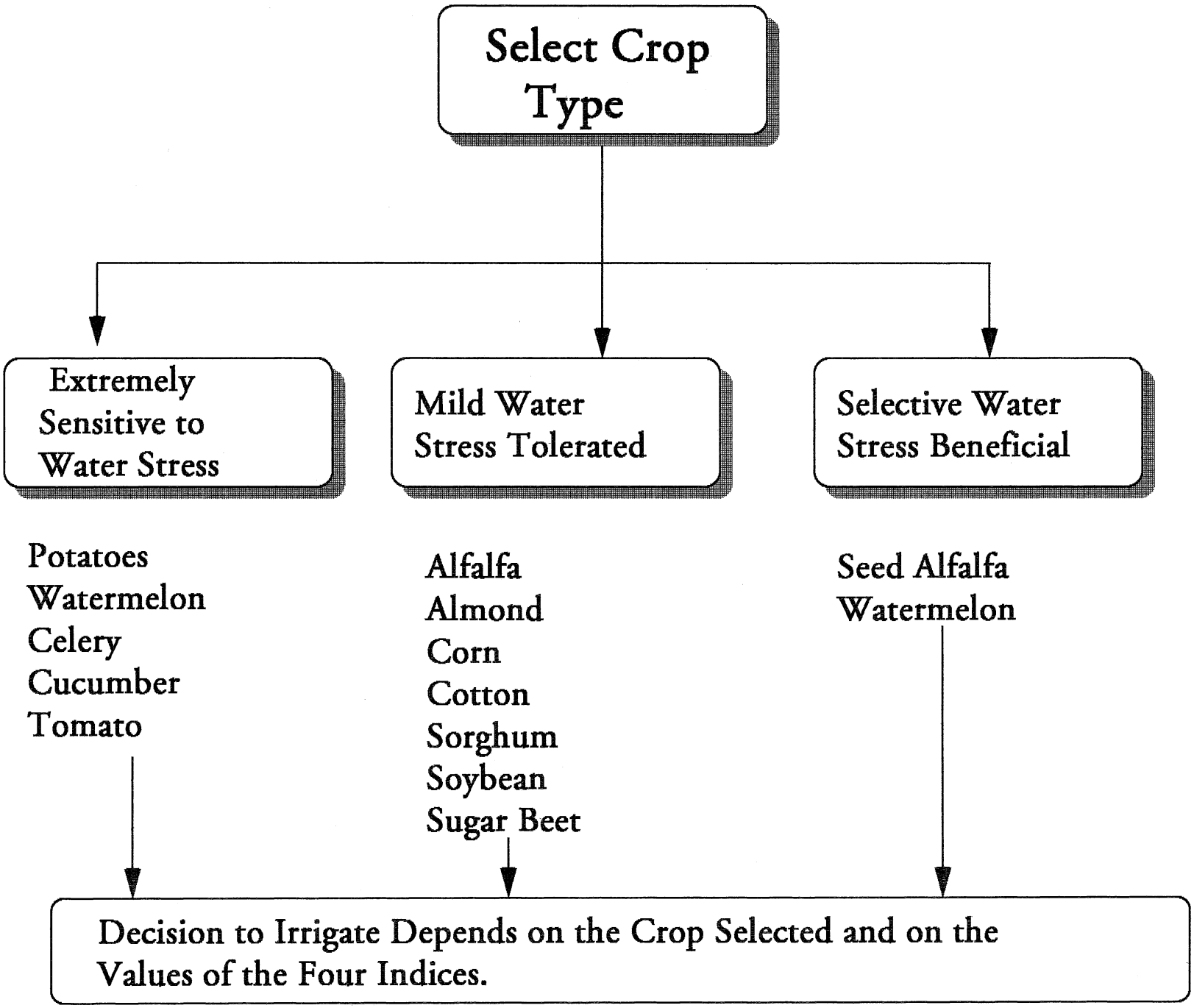
IRRIGATION SCHEDULING USING CROP TEMPERATURE

Summary of U.S. Patent 4,755,942
July 5, 1988
Bronson Gardner and Melvin Keener

Objective: Schedule irrigation on commercial fields using remote sensing information


Is Solar Radiation Stable ?
No
Use non-remote sensing method
Yes
Record Essential Data
Canopy Temperatures
Relative Humidity
Solar Radiation
Wind Speed
Crop type
IRRIGATION ALGORITHMS


IRRIGATION ALGORITHMS
Compute value of Idso CWSI
> Critical Value ?
Compute value of Jackson CWSI
> Critical Value ?
Compute STD of Crop Temp.
> Normal Value ?
Compute Mean Crop Temp.
> Physiologically Safe Value ?


Select Crop Type
Extremely Sensitive to Water Stress
Mild Water Stress Tolerated
Selective Water Stress Beneficial
Potatoes
Watermelon
Celery
Cucumber
Tomato
Alfalfa
Almond
Corn
Cotton
Sorghum
Soybean
Sugar Beet
Seed Alfalfa
Watermelon
Decision to Irrigate Depends on the Crop Selected and on the Values of the Four Indices.

Lessons Learned

I. Remote Sensing Users may have crops which differ from those with which the researcher has experience. For example, the water management of tomatoes differs significantly from the water management of cotton.

II. Growers are reluctant to rely exclusively on remote sensing for economically important decisions. Growers often demand information on how the remote sensing technique corresponds with existing techniques (for example, a CWSI value of x = a LWP of y). This type of cross-calibration is often difficult, if not impossible. The way information is presented has a strong effect on credibility.

Lessons Learned

III. Large farms operate on tight schedules. The timing of remote sensing information with farm management decision schedules and strategy is critical to success. Growers often schedule irrigation based on the behavior of a pre-selected site or by the calendar. Remote sensing data provided must correlate with grower management strategy.

IV. Remote sensing information should provide economic benefits to the grower. (i.e. labor savings, reductions in water cost, increases in yield or increases in crop quality / uniformity). Can vary from farm to farm.

Demonstration Project

Objective: Demonsrate the economic and environmental benefits of using remote sensing for making integrated farm management system decisions.

I. Consult with growers concerning their decision making strategies and management systems and determine the remote sensing information with the greatest potential benefit for each grower.

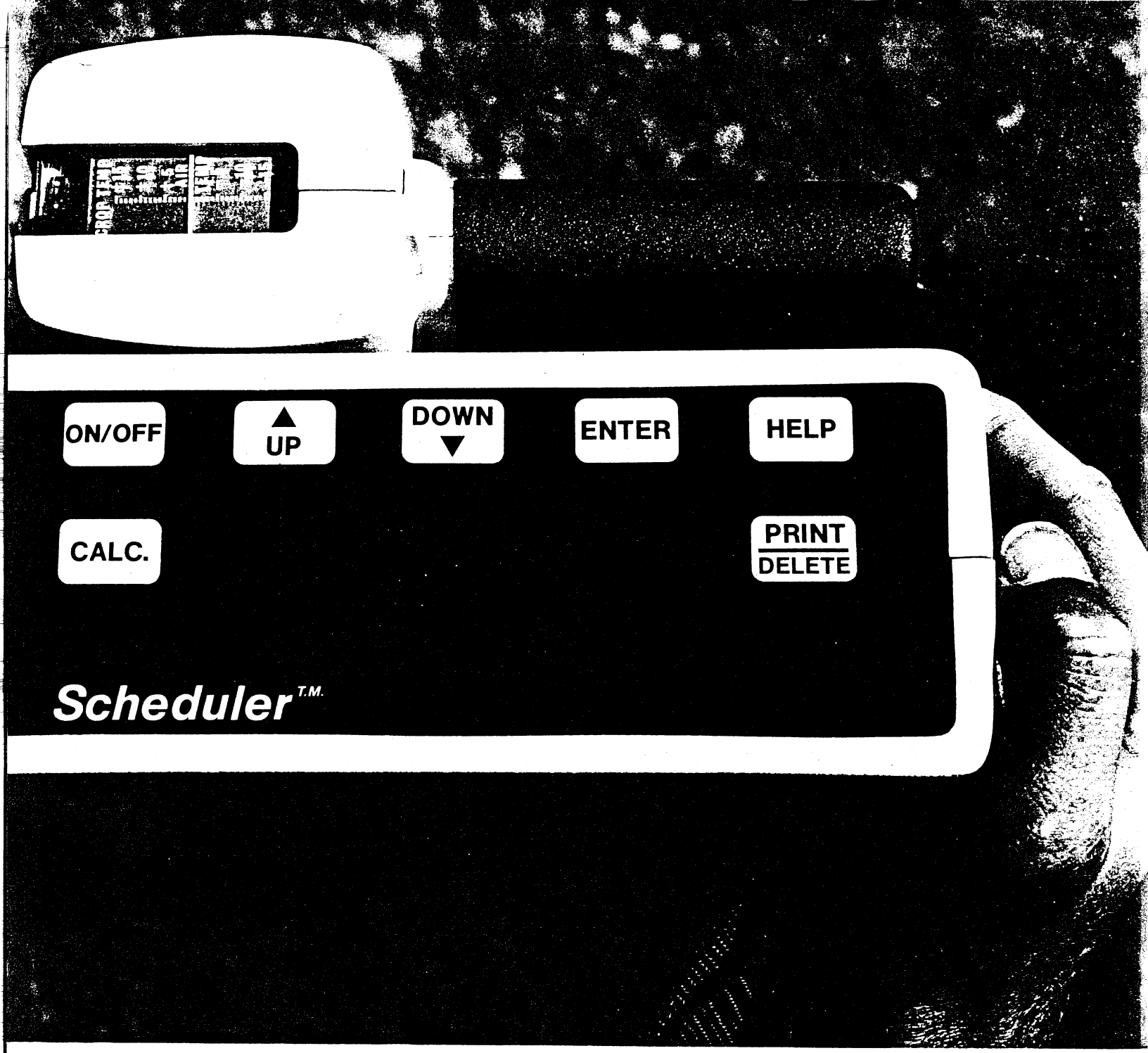
2. Design and test remote sensing data collection system, data "products", and information dissemenation systems. Coordinate efforts with growers, researchers, and other experts.

Demonstration Project

3. Identify new research areas for enhancing and extending the system.

4. Disseminate "progress" information to growers and the public.

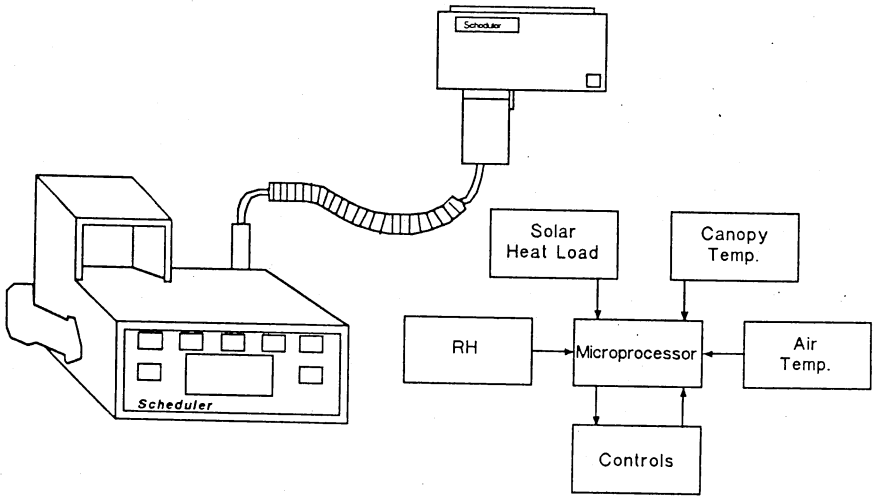
5. Establish a working "prototype" system within 5 years that allows participating growers to make reliable irrigation and farm chemical management decisions using remote sensing information.



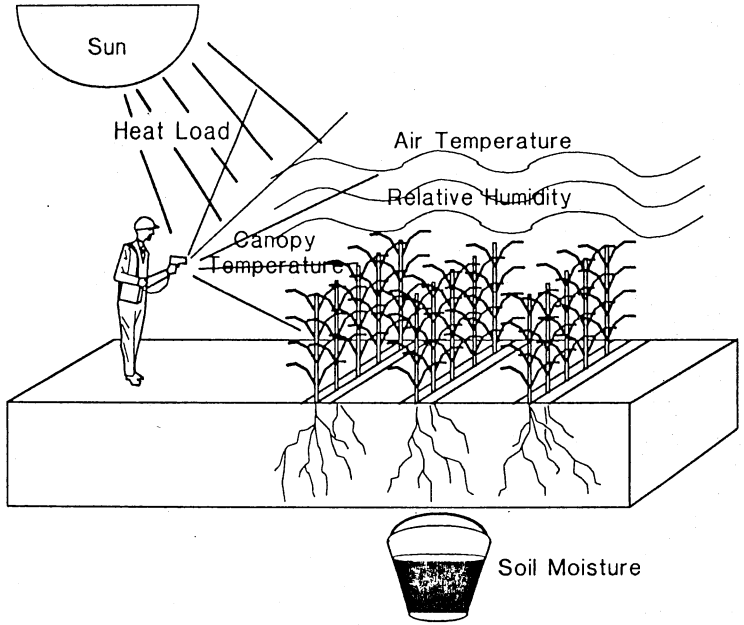
The graphic display on the screen of the Scheduler™ shows how crop stress changes in a field during a 15-day period.

A plant stress reading is taken by pointing the Scheduler™ plant stress monitor at a crop's leaves or canopy. Plant stress increases as the plant's need for water increases, and the available soil moisture is insufficient to meet this increased demand. Irrigation can be scheduled easily based on this information.

The Scheduler™ plant stress monitor is a compact six-pound unit that includes a computer, infrared thermometer, and sensors for air temperature, relative humidity and sunlight intensity. The computer calculates plant stress from the various inputs.



THE SCHEDULER™ IS A COMPACT UNIT THAT
REPLACES SEVERAL INDIVIDUAL SCIENTIFIC
TOOLS IN CALCULATING PLANT STRESS



IN A FRACTION OF A SECOND THE SCHEDULER™ COMPUTES PLANT STRESS FROM INFRARED CROP CANOPY TEMPERATURE AND ENVIRONMENTAL CONDITIONS

QUICK REFERENCE CARD

SCHEDULER™ PLANT STRESS MONITOR

SAMPLING GUIDELINES

- Always sample the sunlit side of the crop.
- When taking samples, be sure to point the Gun at foliage--not bare soil or the sky.
- The best sampling time is between 11AM and 4PM.
- Hold the Gun one to three feet above the crop canopy.
- Carry the Gun out of holster and in your hand while taking samples in the field.

MAINTENANCE AND STORAGE GUIDELINES

- Always start the season with new batteries.
- Remove batteries at the end of the season or for prolonged storage.
- Never store the Monitor in direct sunlight for a prolonged period (the dash of a pickup truck, for example).
- Never store or use the Monitor in a cold environment (below 50°F).
- Avoid exposing the Monitor to wet or extremely damp conditions.

For complete instructions on use and operations consult the Operator's Manual

SCHEDULER SUPPORT SOFTWARE
R&D MODEL
COPYRIGHT 1989, CARBORUNDUM

SCHEDULER SUPPORT SOFTWARE
R&D MODEL
COPYRIGHT 1989, CARBORUNDUM

SCHEDULER SUPPORT SOFTWARE
PRODUCTION MODEL
COPYRIGHT 1989, CARBORUNDUM

SCHEDULER SUPPORT SOFTWARE
PRODUCTION MODEL
COPYRIGHT 1989, CARBORUNDUM

R&D SALES STRATEGIES

- Focus on Four R&D Areas:

  (Private and Public)

  - Pure Research
  - ET/Stress Research
  - Extension
  - Greenhouse/Growth Chamber

- Centers of Excellence Program

- Advertisements in Professional Journals

- Product Exposure at Professional Meetings

- Direct Mailings

- Campus Seminars

- Speeches/Articles

- Direct Telephone Contacts

PRODUCT DEVELOPMENT

New R&D Data-Logger Scheduler Software

- More Flexible Data Storage
- Faster Operating Speed
- User-Defined Baselines
- More Options in Output Formats for External Devices

1988 OPERATIONS MEETING

AREAS OF RESPONSIBILITY

- R&D Sales

- Product Development (New Scheduler Applications)

- Product Support

PRODUCT SUPPORT

Direct Link to Customers

- Assist in Technical Problems (Computer Downloading)
- Assist in Product Use Training and Data Interpretation

Croplink Support

- ET Calculations
- Reports

Research

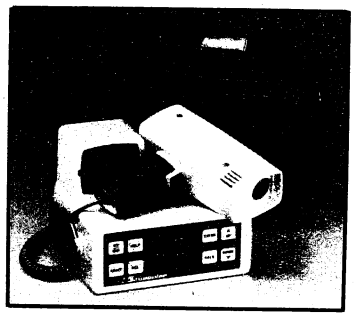
- New Baselines
- Analysis of Customer Data

PC Software for ST27 and Scheduler

- Interpretation Techniques Automated
- Data Management
- Reports

State-of-the-Art
CROP MONITORING

The Agricultural Engineering 50 1987



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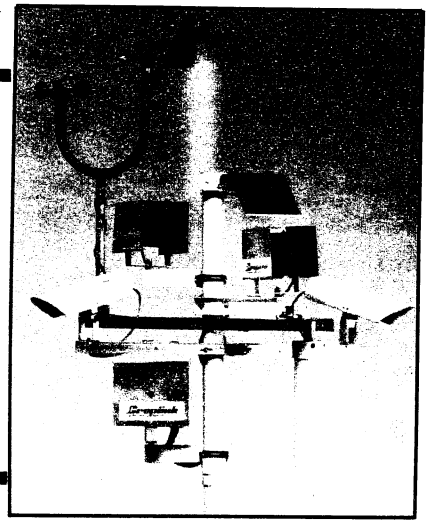

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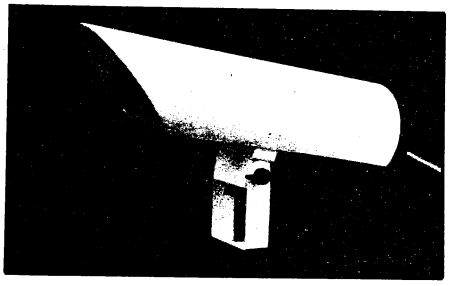
- No computer experience needed
- Research utilities:
  - selective file exporting
  - easy sensor calibration
  - summary statistics for each sensor
- Operate 1-10 stations simultaneously
- IBM compatible. Color or B&W
- Only 400 K RAM required

TELEMETRY:
- Infrared line of site for linking station in up to 1 mile intervals
- Radio when distance between stations is greater than 1 mile

STANDARD HARDWARE:
- Infrared thermometer
- Relative humidity
- Aspirated air temp
- Wind speed
- Wind direction
- Solar radiation
- Solar panel
- Field station
- Base station
- Quality sensors
- Low maintenance
- Add your own sensors



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Target range	– 40°C to + 50°C	Repeatability	0.2°C
Spectral range	8-14 microns	Operating range	– 10°C to 70°C
Accuracy	+/– 1° Celcius	Response time	500 milliseconds
Emissivity	0.99		

CARBORUNDUM

Instrument Technologies
P.O. Box 391377
Solon, OH 44139
(800) 356-0458

APPENDIX

TEMPERATURE COMPENSATION

Adjusting the output of an infrared thermometer for changes in the physical temperature of the infrared sensor is called temperature compensation. In the past, some companies have developed designs which accomplish temperature compensation through the use of mechanical choppers. Recent designs allow for temperature compensation without the use of mechanical choppers. Graham et al. (1989) show that an accuracy of at least 0.2 C can be maintained even when an unprotected, uninsulated, non-mechanically chopped infrared sensor is exposed to a step change of 20 C in ambient conditions.

The Scheduler® infrared thermometer is temperature compensated, although it does not contain a mechanical chopper. Not all infrared thermometers without a mechanical chopper are temperature compensated. The caution that Jackson (1982) gave is still applicable : "It is highly recommended that a potential purchaser determine whether an adequate temperature compensation circuit is an integral part of any instrument intended for field use" . To this we can now add that temperature compensation can be achieved through the use of mechnical choppers or through the use of modern thermal designs and computing techniques.

Special Seminar

Standard Oil
Engineered Materials Company
Sensor Technologies

"The Scheduler"

Date: Wednesday, March 30

Time: 7 p.m.

Location: AE 12B

"The Scheduler"™ is the new state-of-the art infrared-thermometer which is used to predict crop stress. The device is hand-held, and measures plant surface temperatures, air temperature, relative humidity, visible light intensity, and vapor deficit.

The on-board computer estimates crop water stress, which is a valuable aid to predict irrigation timing.

The information can be downloaded to computers with the built-in RS-232 interface.

Standard Oil is providing 3 of these units to Cal Poly on a special loan basis, free of charge. One will go to each of these departments for instructional and student use: Ag. Engr., Soil Science, and Crop Science.

Dr. Bronson R. Gardner, Standard Oil's Product Technical Manager, will present The Scheduler™ and discuss its use in Agriculture and Greenhouses.

For more info, contact Dr. Charles Burt, Dept. of Ag. Engr.

Sensor Technologies

Technology Facilitates Optimum Irrigation

Irrigation involves a delicate balance in plant health. Too much – too soon, or too little – too late can have a catastrophic effect on your crops, hence on your harvest and ultimately on your livelihood.

The Scheduler® Plant Stress Monitor, from Standard Oil Engineered Materials,can change all that. It's a lightweight portable instrument that calculates plant stress as a timely and accurate indication of when to irrigate.

The Guesswork is Gone

Scheduler has been successfully field tested (literally!) on many crops. The stress algorithms were developed by our research center in Ohio. Ongoing R & D is formulating algorithms for other major crops plus turf and ornamentals.

Scheduler uses a package of sensitive sensors and a dedicated microprocessor to detect a crop's physiological need for water several days before any physical symptom can be detected by human senses. The stress reflecting this need is initiated by the inability of the root system to absorb enough moisture from the soil. Failure to irrigate until symptoms become evident can impair crop yields, so early detection is vital.

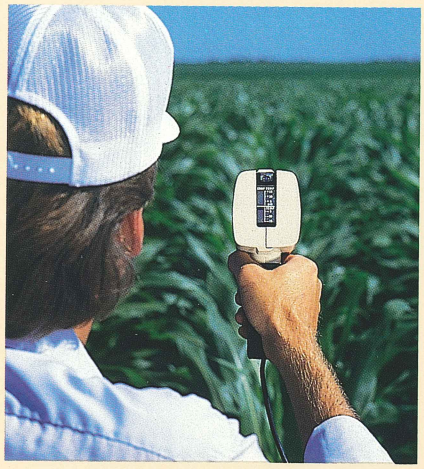
Compact, easy to carry and set up, the Scheduler monitor scans individual fields, large or small, and displays the crop status data on its LCD screen. The instrument is simple to operate and no technical knowledge is needed to use it successfully.

The reported status is a stress index, indicating the relative amount of stress currently felt by the crop. Although early stages of plant stress caused by inadequate moisture absorption cannot be physically detected, even by an experienced grower, they are reliably measured and reported by the Scheduler monitor.

Standard Oil
Engineered Materials Company
Sensor Technologies
P.O. Box 391316
Solon, Ohio 44139
Telephone: 216 349-6881

The monitor reading can tell a grower to irrigate a particular field in time to avoid the possibility of reduced yield or crop damage. On the other hand, it clearly indicates when water is not needed, avoiding costly and potentially damaging over-irrigation.

Some crops appear to need a small degree of moisture stress at certain times to stimulate flowering, increase fruit sugar or avoid disease. This can be safely and easily accommodated with the plant stress monitor.



A Growth Situation

The Scheduler monitor will likely prove useful for overall crop management, since the plant stress it measures can be caused by disease, a harsh environment or insect damage, not just by deficiency in soil moisture. The monitor calculates, displays and stores the stress index and can later use the stored readings to provide stress index trends as management aids.

Also in the development stage is a fully automatic version of the Scheduler monitor, designed to be mounted on center-pivot or other sprinkler systems. It would be programmed to monitor the crop at scheduled times and communicate directly with the irrigation control system to start and stop the sprinklers.

Of course, the value of both instruments will be further enhanced as we develop algorithms for other irrigated crop species. In time, the usefulness of the plant stress monitor can be expected to extend across a wide spectrum of field crops. It is a fascinating example of sophisticated technology coming to the aid of one of man's oldest activities. Hopefully a valuable legacy of Standard Oil Engineered Materials Company.

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CARBORUNDUM® PRODUCTS

The company with the commitment.
—To supply industry with products that increase productivity, improve quality, conserve energy.
—To engineer solutions to tough 20th century problems.
—To develop new technologies and new products that will meet even more needs.
—To quality in everything we do.

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The Fiberfrax® high temperature ceramic fiber insulating products made by this division assure superior insulating qualities and lower energy costs for scores of industries.

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Combat® boron nitride can be used at temperatures to 3000° F in applications including molten metal crucibles, sealing and brazing operations in industrial furnaces, additives and friction modifiers.

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Carborundum® electric gas igniters eliminate the need for gas-wasting pilot lights in domestic and commercial appliances.

Carborundum® non-inductive ceramic resistors can handle excessive amounts of voltage, current and energy.

Globar® heating elements assure a reliable, clean source of heat in electric furnaces and kilns.

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The unsaturated polyester resins made by Silmar are used in a variety of applications including boat decks, surfboards, truck-cab finishes, electrical components and molding compounds.

Filon uses these resins to manufacture translucent fiberglass reinforced panels for greenhouses, patio covers, sanitary wall linings, recreational vehicle exterior sidewalls, solar energy collector covers and fences and similar structures.

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Impervite® impervious graphite and Hexoloy® SiC heat exchangers provide corrosion-proof heat transfer application involving acids, solvents and other difficult materials.

Carborundum® specialty graphite products includes carbon and graphite felt for superior high temperature insulation, and graphite tubes and rods for superior strength at elevated temperatures with exceptional resistance to corrosion and thermal shock.

Ekonol™ high temperature polyester resin for flame sprayed coatings are used in turbine engines and for blending with fluoropolymers as a reinforcing agent.

Technology Division
216 581-5600
This division is responsible for research aimed at developing new materials and technologies for applications in structural and electronic ceramics, solar energy and the company's traditional product lines manufactured by the Fibers and Refractories divisions.

Scheduler™ Plant Stress Monitor
216 581-5538
The Scheduler™ plant stress monitor measures the critical factors for determining irrigation requirements such as soil moisture and type, compaction, insect damage and diseases. The lightweight, portable, battery-powered Scheduler plant stress monitor is simple to operate and requires no technical expertise.

When industry has a problem nobody else can solve.

STANDARD OIL
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Standard Oil
Engineered Materials Company
P.O. Box 156
Niagara Falls, New York 14302

Scheduler ™
ON OFF
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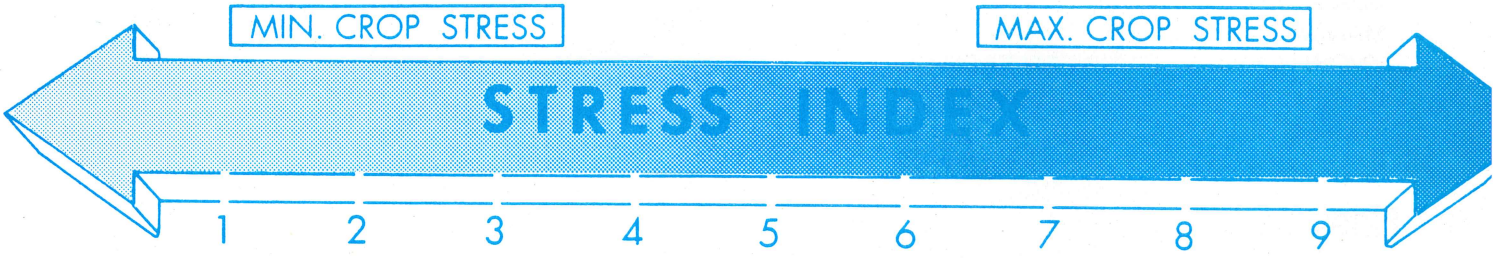
CALC
DOWN
Scheduler

INSTRUMENT TECHNOLOGIES

The Crop Stress Index Story

...The crop stress index, originally developed by the United States Department of Agriculture (U.S.D.A.) is simply a calculation of actual plant health, based on measuring the plant and its environment.

The index is a result of years of extensive government, university and private research aimed at developing crop models that accurately calculate the plant's relationship to its environment. The easy-to-use 0-10 scale offers you an accurate way to determine when a plant is not reaching its full potential or is experiencing stress that can threaten crop yield.



The Carborundum Co. developed the first commercial instrument dedicated to measuring the crop stress index -- The SCHEDULER® Plant Stress Monitor. Since 1985, The Scheduler® monitor has been used effectively on many commercial crops, including:

alfalfa
almonds
apples
cantaloups
corn
cotton
grapes
pecans
potatoes
tomatoes
sorghum
sugar beets
watermelon

The Scheduler® monitor is in routine use in many states and foreign countries.

The Agricultural Engineering 50

DETECTS STRESS

. . . TOO LITTLE/TOO MUCH WATER
. . . SALT - COMPACTION - INSECTS - DISEASE-CHEMICALS

INCREASES EFFICIENCY

. . . SAMPLE LARGE AREAS FAST
. . . PC COMPATIBLE
. . . PORTABLE - SAMPLE ANYWHERE
. . . IMPROVE CROP UNIFORMITY

PRODUCT SUPPORT

. . . PC SOFTWARE FOR QUICK DAILY AND SEASONAL REPORTS
. . . MANUALS/TUTORIALS
. . . KNOW-HOW BULLETINS FOR EACH CROP
. . . 24-48 HOUR DELIVERY - ANYWHERE IN THE UNITED STATES
. . . CALL 1-800-356-0458 FOR ASSISTANCE

FIELD TESTED

. . . THE FIRST LARGE - SCALE NATIONWIDE TEST OF THE USDA CROP WATER STRESS INDEX (CWSI)
. . . THE FIRST COMMERCIAL CWSI - BASED SYSTEM
. . . HUNDREDS OF UNIVERSITY, GOVERNMENT AND PRIVATE OWNERS SINCE 1985
. . . VALIDATED ON OVER 20 CROPS - CAN BE USED ON MANY MORE
. . . OUR CUSTOMERS ARE THE LARGEST GROUP OF CWSI USERS IN THE WORLD
. . . DEMONSTRATED EFFECTIVE IN CONTROLLED EXPERIMENTS

FEATURES

INFRARED THERMOMETER, AIR TEMPERATURE, RELATIVE HUMIDITY, SOLAR RADIATION, AND EXCELLENT DATA LOGGING CAPABILITY. INTERFACES WITH POLYCORDERS AND OTHER DATA-LOGGERS

PROGRAMMABLE FOR ANY CWSI EQUATION.

- Easy to use.
- The ideal companion to soil moisture measurements. Soil measurements indicate how much water is available. The Scheduler® monitor indicates when plants are having difficulty extracting needed soil moisture.
- Computer skills not required.
- Generic indices for use on any crop.

Give us a call. Let the SCHEDULER® Plant Stress Monitor assist you in your crop monitoring needs.

CARBORUNDUM

The Carborundum Company
Instrument Technologies
6180 Cochran Road
P. O. Box 391377
Solon, Ohio 44139
216 349-6881
1-800-356-0458

The Agricultural Engineering 50

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Croplink™
Crop Monitoring Systems

Standard Oil Engineered Materials Company, P.O. Box 156, Niagara Falls, New York 14302 Made in U.S.A.

Scheduler™
Plant Stress Monitor

picture of plant health than does an infrared thermometer alone.

All of the leaf and environmental measurements collected by the Scheduler's sensor gun go to a shoulder-pack computer for an instant calculation of plant stress in the field. On-the-spot crop management decisions can be made to reach targeted yields and to maintain high levels of crop quality.

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216 349-6881

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Form A-15,051
New 4/87

Using infrared thermometry to measure canopy temperature

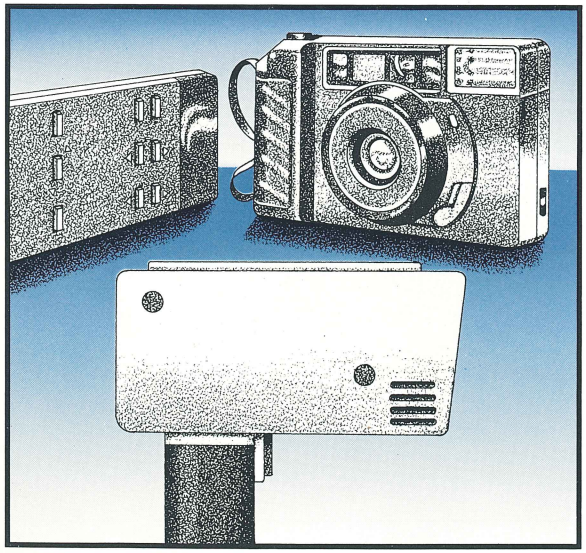
Scheduler™
Plant Stress Monitor

What is an infrared thermometer?

The human eye receives visible light waves and interprets those light waves as a color picture for the sense of sight. An infrared thermometer, much like your eye, sees invisible light waves and measures them as temperature.

You're probably more familiar with infrared technology than you realize. Remote controls turn television sets and VCRs on and off by infrared signals, and infrared photography is used in a number of ways for evaluating irrigation and drainage patterns in agriculture. Infrared thermometry is just another form of infrared technology.

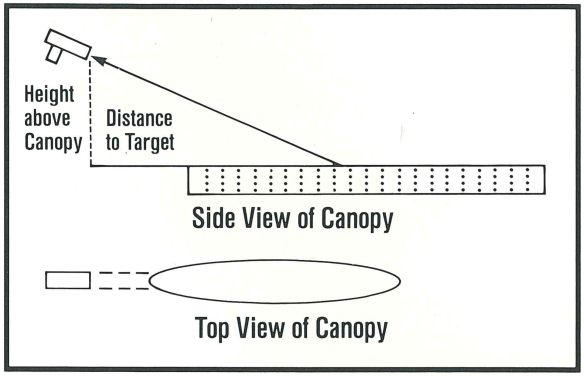
An infrared thermometer detects heat coming from a plant's leaf and records the temperature reading. Leaf temperature is the indicator of how well the crop is absorbing moisture from the soil profile. This information is vital to controlling stress and reaching targeted crop yields and quality.



Taking readings of leaf temperature

Leaf temperature can be identified for a large area or a single plant, depending on the thermometer's distance from the crop and height above the canopy.

The thermometer is aimed like a gun, but its viewing field is more like that of a flashlight, resembling a long, narrow, cigar-shaped oval.

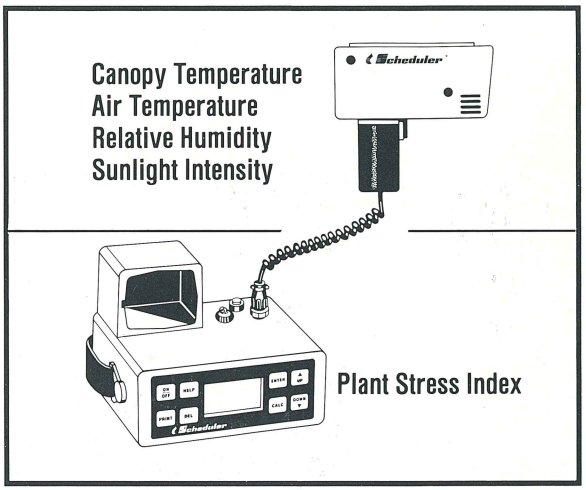


Going beyond infrared thermometry

The Scheduler™ Plant Stress Monitor from Standard Oil Engineered Materials Company measures leaf temperature and the environmental factors influencing that temperature. Those factors include air temperature, relative humidity, and the intensity of the sunlight.

The computing ability of the Scheduler provides growers with a more complete and accurate

fields' environment, to compute the plant stress index based on these measurements.



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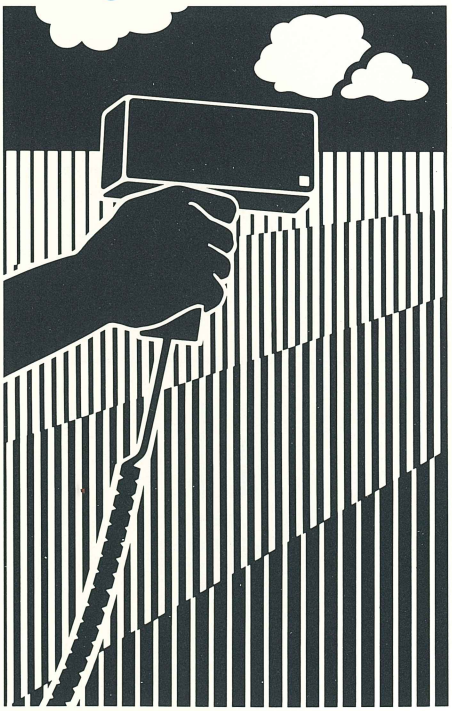
Form A-15,052
New 4/87

Using the plant stress index to reach targeted yields

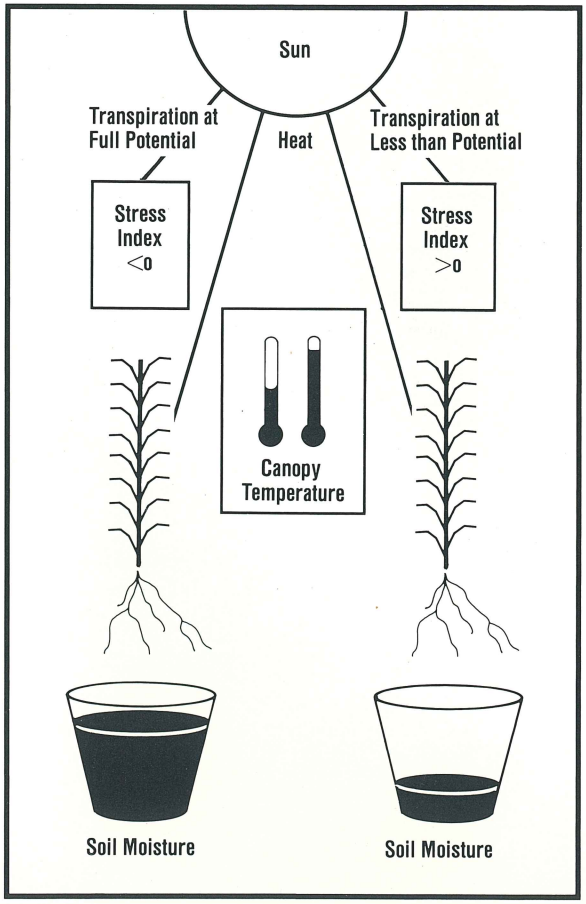


Scheduler™
Plant Stress Monitor

Controlling crop stress

The plant stress index is a new way for growers to control crop stress, ensuring healthy crops and maximum yield. Developed by the Standard Oil Engineered Materials Company, the index is based on USDA and university research of plant leaf temperature, its role in identifying crop stress, and its influence on irrigation scheduling.

Leaf temperature is a vital sign of plant health and an important part of the plant stress index. It is an indication of how well a plant is absorbing moisture from the soil. Because the index offers precise information on the plant's health, you can identify crop stress three to five days before stress can be visually detected. Irrigation timing can be based on crop requirements at certain growth stages and points critical to yield.



Predictable behavior

Generally, a well-watered, healthy plant has a leaf temperature cooler than the surrounding air temperature. Just as a rise in temperature causes a person's body to feel warm to the touch, so does a plant leaf predictably feel warm to the touch when its temperature goes up.

Leaf temperature is affected by the rate of evaporating moisture from its surface. This rate of evaporating moisture is known as the transpiration rate. The transpiration rate determines the plant leaf temperature and its ability to optimize plant growth and production. Water stress causes the leaf's transpiration rate to lower and the leaf temperature to rise.

To identify water stress and the correct leaf temperature, air temperature, relative humidity, and intensity of the sunlight must also be measured. The plant stress index is calculated based upon all of these influences on the plant, and provides growers with a measuring scale for accurate readings of crop health. With the plant stress index, growers can easily determine when a plant is not transpiring at its full potential.

Getting plant facts with the SCHEDULER™

The Scheduler™ Plant Stress Monitor was designed to measure the plant in its environment above the ground and to equate that information to the plant's requirements below the ground. The Scheduler measures leaf temperature and the